National Aeronautics and
Space Administration

Educational Product	
Educators & Students	Grades K–12

EB-2001-12-013-JPL

Educational Brief

CASSINI SCIENCE INVESTIGATION

Which Way Should I Point?

Objective

To illustrate the need for cooperation among competing interests to make scientific measurements of planetary phenomena using "body-fixed" instruments.

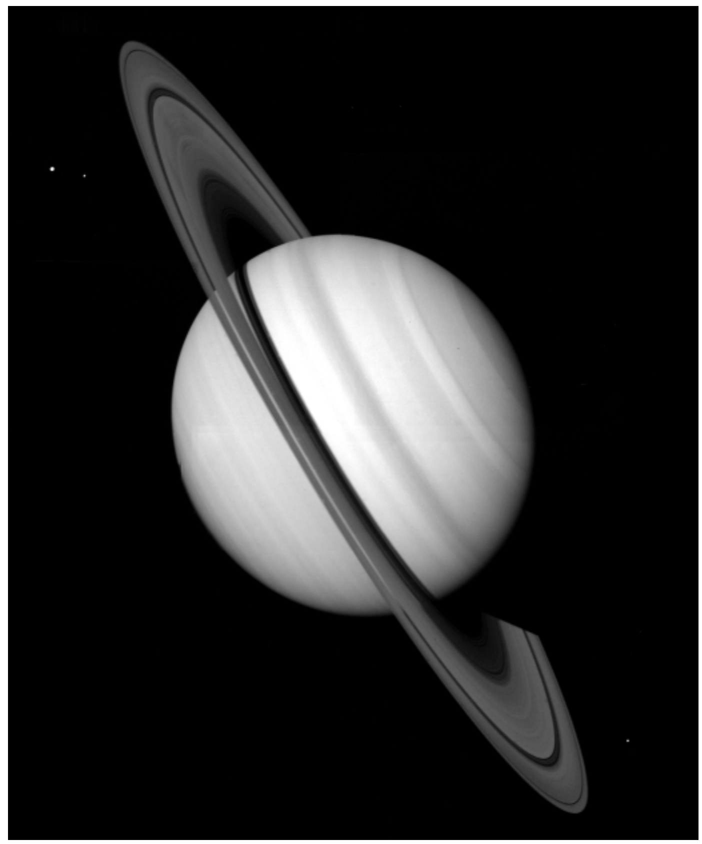
Time Required: 1 hour

Saturn System Analogy: Cassini orbiter science investigations

Keywords: Field of View, Orientation, Rotation

MATERIALS

- A desk chair that swivels
- A board that is wide and thick enough to support three people
- A brimmed hat, preferably a cowboy or outback hat
- One small toy telescope
- One pair of binoculars
- A broom handle (available at hardware stores or large wholesale kitchen supply stores)
- Three student volunteers
- An image or drawing of Saturn: this can be a photograph, a store-bought cut-out, or a download from the Internet (*http://www.jpl.nasa.gov/cassini/english/pic/saturnsystem.html*)



Saturn and three of its moons as seen by Voyager 1.

Discussion

The Voyager and Galileo spacecraft had some instruments mounted on a scan platform. This scan platform is a platform that can move independently from the rest of the spacecraft, something like a robotic arm.

Cassini, in contrast, does not have a scan platform. All of Cassini's science instruments are attached directly to the main body of the spacecraft. As a result, in order to orient an instrument to point at Saturn (or any other target), the entire spacecraft must move. This means that while the camera is taking a picture of Saturn, all of the other instruments must look in their pre-defined directions, which may not be parallel to the camera's direction. This makes coordinating observations and data collection using the 12 instruments very difficult.

Procedure

Mount the image of Saturn somewhere in the classroom.

Place the board on the swivel chair. Have the first student volunteer sit on the center of the board and have the student hold the hat upside-down on top of his/her head. The hat represents Cassini's high-gain antenna (the main communication antenna for the spacecraft).

Give the student the small toy telescope and instruct him/her that the telescope can only move up and down. The telescope represents the Magnetospheric Imaging Instrument (MIMI, *http://saturn.jpl.nasa.gov/cassini/Science/MAPS/MIMI.shtml*).

With someone holding one end of the board so that it does not tip over, place the second student volunteer on the other end of the board with his/her back to the person in the center. Give the second student the binoculars. These binoculars represent the Imaging Science Subsystem (the cameras, ISS, *http://saturn.jpl.nasa.gov/cassini/Science/MAPS/ISS.shtml*). One lens of the binoculars is the wide-angle camera and the other lens is the narrow-angle camera. Instruct the student that he/she can only look straight ahead.

Place the third student volunteer on the other end of the board with his/her back toward the person in the center. Give the third student the broom handle and instruct him/her to hold it out in front. The broom handle represents the Magnetometer (MAG, *http://saturn.jpl.nasa.gov/cassini/Science/MAPS/MAG.shtml*).

Taking Data with the "Spacecraft"

Now that all three of the students are in position, it's time to acquire some data about Saturn, which is mounted somewhere in the classroom (first procedure step). Let's try to collect some data.

The magnetometer (MAG) is collecting data on Saturn's magnetic field. Therefore, as long as the instrument is turned on, it does not need to point in any particular direction (for the purpose of this demonstration).

The Magnetospheric Imaging Instrument (MIMI) and Imaging Science Subsystem (ISS) are a whole different story. Since both ISS and MIMI need to actually look (point) at Saturn to collect data, it's obvious that they cannot collect data at the same time. In real mission planning, there is a sequence of events that is predefined wherein one of these instruments collects data, and then the other has a chance. The discussion comes when both science teams want to collect data at the same time. The mission planning team then needs to negotiate a bargain between the two teams.

Remember that this demonstration only uses three of Cassini's 12 instruments!

Extension

Demonstrate the difference between a body-mounted-instrument spacecraft like Cassini and a spacecraft with a scan platform like Galileo. This illustrates the difficulties presented to the Cassini science and engineering teams when they plan data collection using multiple instruments. Now let's examine how Galileo works.

The Galileo spacecraft is somewhat similar in design to Cassini. Galileo has a main antenna at the top of the spacecraft, a central core of electronics, and a main engine at the bottom of the spacecraft. Science instruments are mounted on the outside of the central core. A major difference between Galileo and Cassini is the movable scan platform that allows Galileo's remote sensing instruments (cameras and others) to be positioned to take data almost independent of the spacecraft's orientation.

On the Galileo spacecraft, your student camera (the student with the binoculars) is now free to move his binoculars in order to capture a target. Repeat the procedure used for Cassini, but as you slowly rotate the chair, allow the "camera" to stay pointed at Saturn until the chair is rotated so much that the "camera" is on the other side of the spacecraft from Saturn.

Technology Standards

A visit to the URL http://www.mcrel.org yielded the following standards and included benchmarks that may be applicable to this activity.

4. Understands the nature of technological design.

LEVEL 1 (GRADES K–2)

Knows that people are always inventing new ways to solve problems and accomplish work (e.g., a computer is a machine that helps people work and play).

LEVEL 2 (GRADES 3–5)

Knows constraints that must be considered when designing a solution to a problem (e.g., cost, materials, time, space, safety, scientific laws, engineering principles, construction techniques, appearance, environmental impact, what will happen if the solution fails).

Uses appropriate tools, techniques, and quantitative measurements to implement proposed solutions.

LEVEL 3 (GRADES 6–8)

Evaluates the ability of a technological design to meet criteria established in the original purpose (e.g., considers factors that might affect acceptability and suitability for intended users or beneficiaries; develops measures of quality with respect to these factors), suggests improvements, and tries proposed modifications.

LEVEL 4 (GRADES 9–12)

Evaluates a designed solution and its consequences based on the needs or criteria the solution was designed to meet.

5. Understands the nature and operation of systems.

LEVEL 1 (GRADES K–2)

Understands how some elements of simple systems work together (e.g., people in a restaurant, parts of a bicycle).

LEVEL 2 (GRADES 3–5)

Knows that when things are made up of many parts, the parts usually affect one another.

Understands the relationships between elements (i.e., components, such as people or parts) in systems.

LEVEL 3 (GRADES 6–8)

Knows that systems are usually linked to other systems, both internally and externally, and can contain subsystems as well as operate as subsystems.

Teachers — Please take a moment to evaluate this product at http://ehb2.gsfc.nasa.gov/edcats/educational_brief.
Your evaluation and suggestions are vital to continually improving NASA educational materials. Thank you.

Student Worksheet — Which Way Should I Point?

Procedure

The instructor will engage you, the student, in this demonstration. Some additional questions to answer include:

With the body-mounted-instrument spacecraft, can both instruments take data about Saturn at the same time?

If the answer to the first question is "no," how can the two instruments both collect data about Saturn?

Is it easier for the two instruments on the Galileo spacecraft (with the movable scan platform) to collect data at the same time?

Which spacecraft design, the body-mounted-instrument spacecraft or the one with the scan platform, do you think costs more to build? Why?